

Design and Analysis of a Practical Heliogyro Blade Control System for Deployment and Flight

Completed Technology Project (2015 - 2019)



Project Introduction

A heliogyro spacecraft is a specific type of solar sail that generates thrust from the reflection of solar photons. The proposed research for this fellowship will address the limitations of current analytic models and control designs for a heliogyro spacecraft to develop practical solutions. The first objective is to derive new equations of motion for the essential blade dynamics. The reduced order model for a heliogyro spacecraft will include multiple degrees of freedom, coupled dynamics, solar radiation pressure loading and torque source boundary conditions, all of which are lacking from the current analytic models. The second objective is to develop a root control system that effectively damps the structural modes of a heliogyro spacecraft. The final objective is to determine the blade behavior during initial spin-up of the spacecraft and blade deployment. The main methods used to accomplish these research objectives will include classical control theory in conjunction with impedance control and a thorough understanding of the blade dynamics. The heliogyro spacecraft modeling will begin with simplified linear assumptions. The coupling and nonlinearities will be added incrementally to the model. The propellant-free heliogyro is a long-duration sustainable spacecraft whose maneuverability allows it to attain previously inaccessible orbits for traditional spacecraft. Continuing research in practical heliogyro control will significantly advance the TRL of this innovative design, in turn lowering the cost of existing missions and opening up exciting new mission possibilities.

Anticipated Benefits

The propellant-free heliogyro is a long-duration sustainable spacecraft whose maneuverability allows it to attain previously inaccessible orbits for traditional spacecraft. Continuing research in practical heliogyro control will significantly advance the TRL of this innovative design, in turn lowering the cost of existing missions and opening up exciting new mission possibilities.



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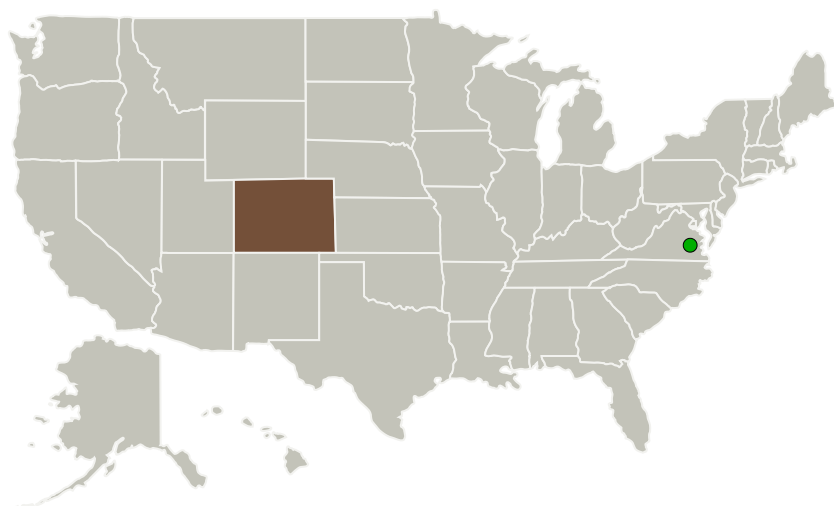
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Lead Organization	Academia	Boulder, Colorado
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations

Colorado

Project Website:

<https://www.nasa.gov/strg#.VQb6T0jJzyE>

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Colorado Boulder

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Dale Lawrence

Co-Investigator:

Sarah Smith-cook

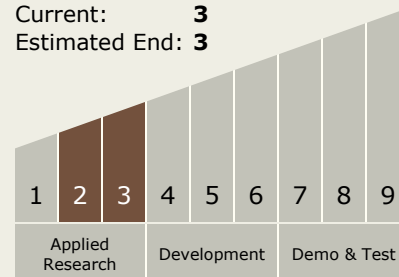
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Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.1 Chemical Space Propulsion
 - └ TX01.1.1 Integrated Systems and Ancillary Technologies

Target Destinations

The Moon, Outside the Solar System, The Sun